

REGIONAL NEEDS AND BENEFITS

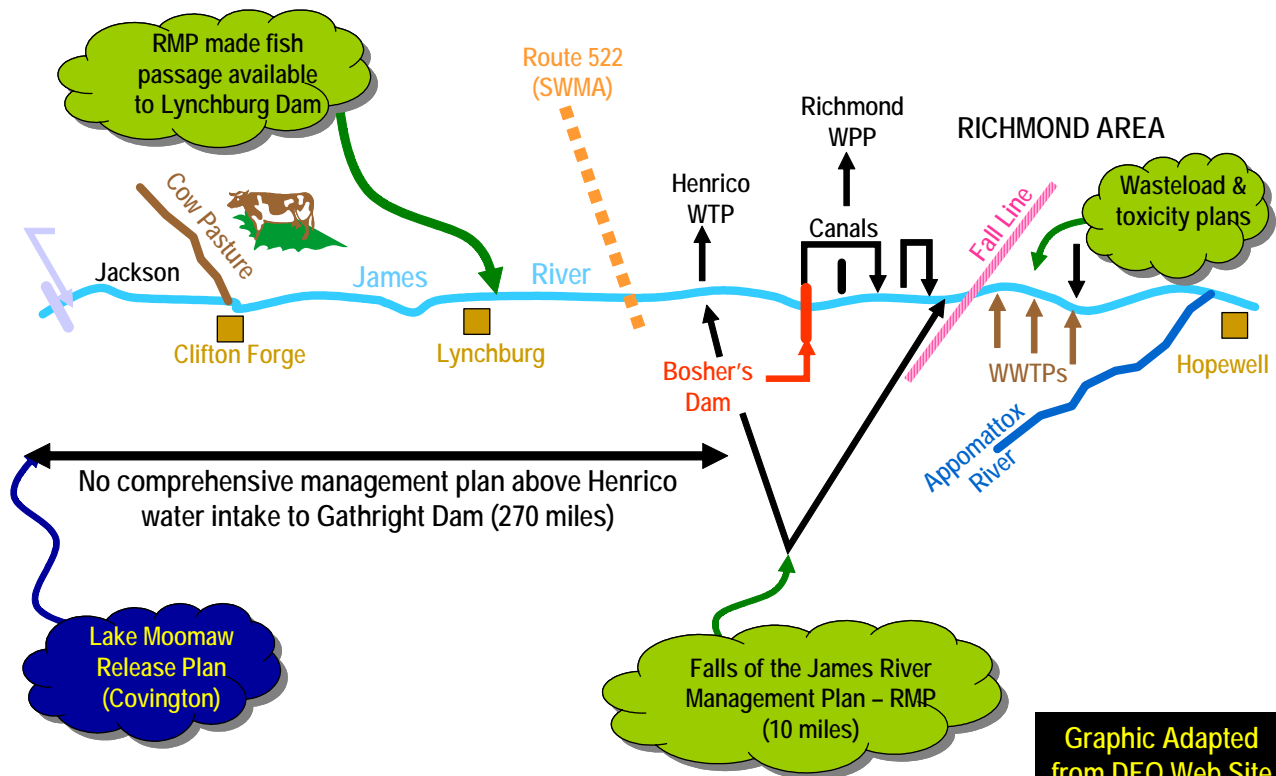
SUMMARY

Water supply needs have been evaluated for a regional partnership of communities along the James River consisting of Cumberland County, Henrico County and Powhatan County. Goochland County is likewise factored into this evaluation since its future water needs will be met by Henrico County under the current water agreement between those two counties.

To meet these growing needs, the Cobbs Creek Reservoir Project has been proposed as a pumped storage facility providing 14.8 billion gallons of raw water storage and estimated raw water safe yield of 53 million gallons per day (mgd). Raw water would be diverted to the reservoir from the James River when river flows are adequate. Reservoir withdrawals and/or controlled releases from reservoir storage would be made during drought and other periods when James River flows are inadequate to support regional demands. This capability to augment flows in the middle James River Basin is a key aspect to this project. Currently, there is no comprehensive management plan and only limited capability to augment flows between Gathright Dam at Lake Moomaw and the Richmond metropolitan area water intakes, a distance of over 270 river miles (see **Figure 1**).

Figure 1

Current Status of the Middle James River Basin

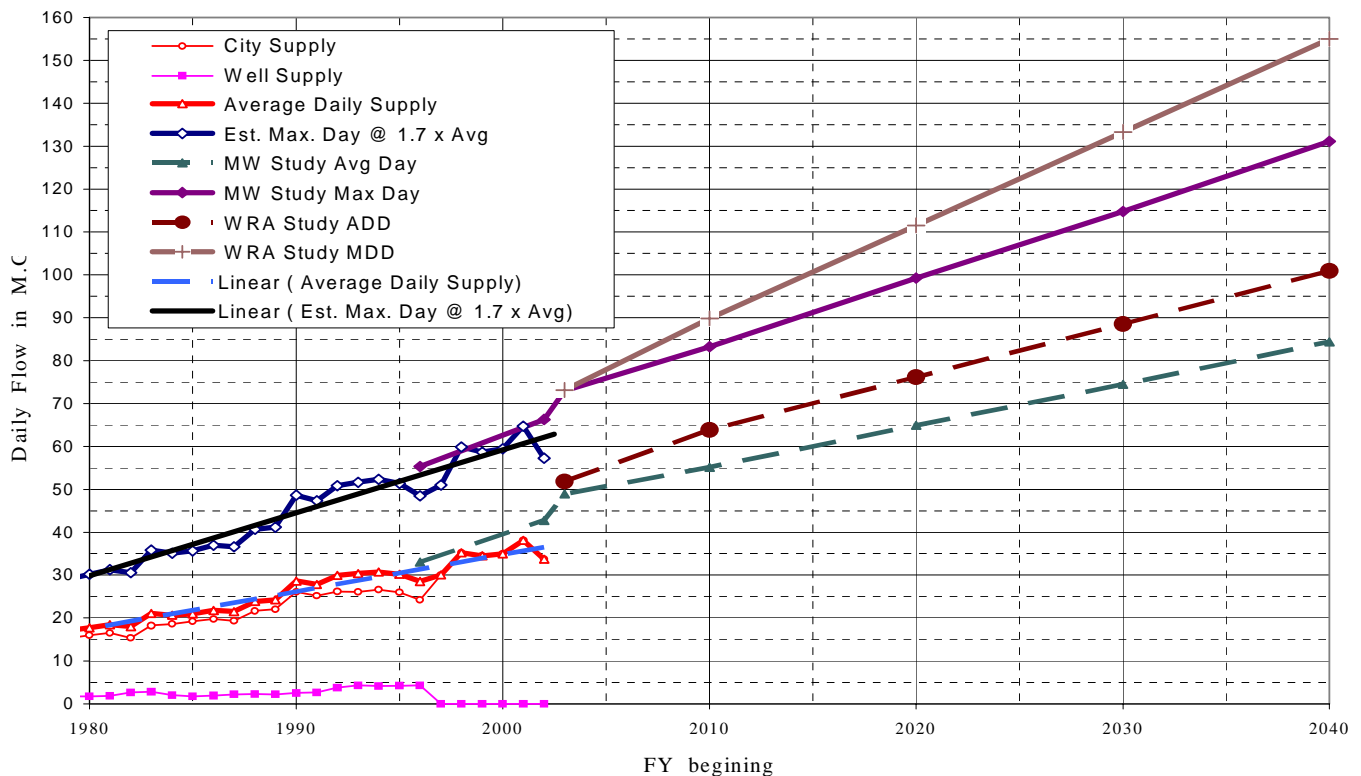


Cumberland County is in need of a reliable water supply source with acceptable water quality. The County currently utilizes a number of small well systems to serve residents and businesses in the County. Many of these systems have experienced water quality problems in recent years. In addition, a number of wells failed during the drought of 2002. For these reasons, the County is pursuing a more reliable source of water with better quality to serve its current customers and to provide for additional future uses.

Henrico County is in need of an additional water supply source to supplement the current permitted supply for its water treatment plant supplied by raw water from the James River. In Spring 2004, Henrico County began producing water from its new intake and water treatment facilities located on the James River a few miles upstream of Boshers Dam. As shown in **Figure 2**, Henrico's projected demands go well beyond the current permitted supply (45 mgd average daily withdrawal for Henrico's water treatment plant plus up to 35 mgd purchase from Richmond). Average day demand supplied by Henrico County in 2050 is expected to be at or upwards of 105 mgd.

Figure 2

Water Demand Projections for Henrico County



Powhatan County's most recent projections indicate that it will require additional water supply by 2015. Recent experience during the drought of 2002 confirms that there is a need in the middle James River Basin for additional capability to augment flows during low flow periods for the protection of both instream uses and public water supplies.

As listed below, numerous benefits would result from development in Cumberland County of a new offstream reservoir on Cobbs Creek to meet the region's growing water supply needs.

- Additional water supply and enhanced reliability for the project partners, and also for downstream public water systems like the City of Richmond.
- River flow augmentation sufficient to minimize the occurrence of low river flows that trigger the use of mandatory water conservation measures. The City of Richmond and Henrico County are currently required to implement use restrictions under the James River Regional Flow Management Plan for the Falls of the James Area (RMP).
- River flow augmentation sufficient to supply a portion of the water supply needs of downstream users under all flow conditions. For example, water released from the project would be available for use by Henrico County during low flow conditions.
- Improved instream flows between a Cumberland Reservoir discharge point and Henrico's water intake and extending into the Richmond area.
- Maintenance of flows that better protect instream uses such as anadromous fish passage, fisheries habitat and nursery areas, and water quality.
- Enhancement of recreational uses from the point of a Cumberland Reservoir discharge to the Fall Line.
- A recreation amenity to Cumberland County citizens and others who will visit the reservoir.

Methods used for analyzing potential reservoir benefits are detailed in a subsequent section of this document. Evaluated reservoir configurations were found capable of fully augmenting low flows that were actually experienced in the middle James River from January 1982 through June 2003. Analysis based on historical flows prior to 1982 does not as accurately reflect current conditions since flow management at Lake Moomaw was not yet in place. Augmentation releases avoided all days with river flow below the trigger for mandatory conservation measures, and provided 10 percent of the water demand of downstream users (Richmond and Henrico) on all days with river flow below the trigger for voluntary conservation measures.

Drought conditions experienced in the James River during 2002 are considered in a subsequent section of this document. In response to the 2002 drought, the Virginia General Assembly in concert with the Governor passed legislation which directs the Virginia Department of Environmental Quality (VDEQ) to develop regulations to direct the development of water supply plans for every locality in Virginia. The regulations will require plans designed to ensure that adequate and safe drinking water is available to all citizens of the Commonwealth, and encourage, promote, and protect all other beneficial uses of the Commonwealth's water resources. The Cobbs Creek Reservoir Project is consistent with these objectives and is a model for regional cooperation to serve a greater need as opposed to serving only a single community.

DROUGHT CONDITIONS OF 2002

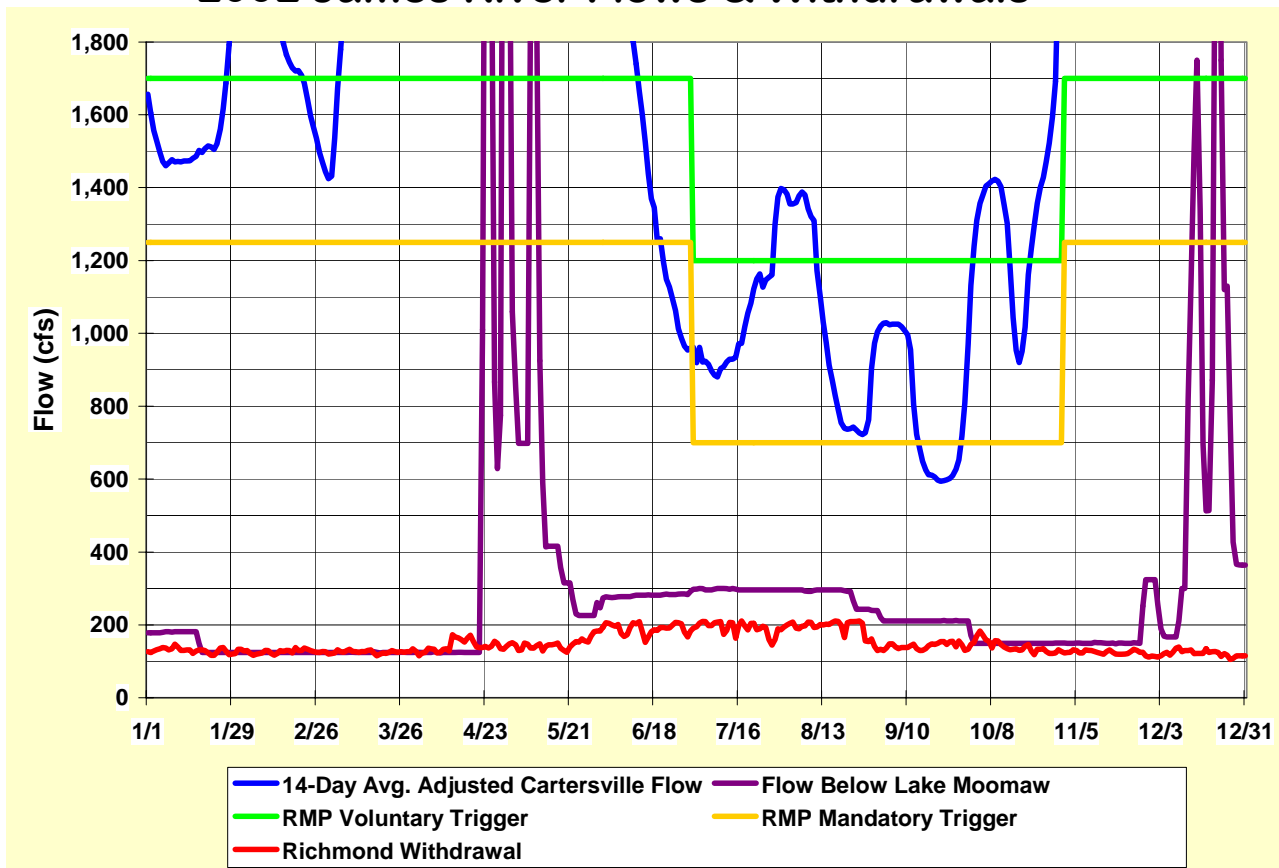
Severe drought conditions occurred in the James River system from mid-2001 through fall 2002. For the 16-month period of June 2001 through October 2002, all but three months had average flow less than 2000 cfs as measured at the James River at Cartersville gage. Only two other periods during that gage's 105-year record had comparable low flows for such an extended period of time.

Flows in the James River upstream of Henrico County's intake dropped below the RMP trigger value that requires mandatory water conservation measures for most of the period from mid-June through late September 2002 (see **Figure 3**). Due to these low flows, water use restrictions were instituted by Richmond and Henrico beginning June 16 and continuing for the remainder of 2002.

Lake Moomaw, which is the only major existing project in the James River Basin above Richmond that provides flow augmentation in dry periods, experienced severe drawdown conditions at this time. By Fall 2002, the conservation pool of Lake Moomaw was two-thirds depleted despite the Corps of Engineers reducing flow releases at the resource agencies' request in an effort to maintain storage levels. At the same time, Lake Moomaw releases represented a significant portion of streamflow measured at the Cartersville gage (see Figure 3). Additional capability to augment James River flows during low flow periods would help protect both instream uses and public water supplies.

Figure 3

2002 James River Flows & Withdrawals



METHODS FOR ANALYZING POTENTIAL RESERVOIR BENEFITS

Analyses were performed of the capabilities of the Cobbs Creek Reservoir Project (as well as other considered reservoir alternatives) to provide reliable water supply and flow augmentation while maintaining instream flows required under the current RMP parameters. Two sets of analyses were performed, in an effort to quantify the project's benefits of supplementing water supply and of augmenting low flows in the middle James River Basin.

One set of analyses assessed the safe yield of the Project assuming traditional reservoir operations (safe yield analysis). This best quantified the project's capability of delivering water for water supply. A second set of analyses assessed the project's ability to augment flows in the middle James River during low flow periods, according to the current RMP rules (flow augmentation analysis). This best quantified the project's capability of augmenting flows in the river for maintaining instream flows.

Model components and assumptions are explained below. The methods of the analysis are consistent with guidance given by DEQ staff during December 2003 discussions of model methods, assumptions and details.

FLOW RECORDS

The models utilize historical flow data recorded at the U.S. Geological Survey (USGS) streamflow gage on the James River at Cartersville, Virginia. Daily flow records were used for determining water available for withdrawal from the James River, and for determining flow augmentation needs. The resulting daily data were then grouped for performing the monthly reservoir operations timestep.

The safe yield analysis was done for the period January 1900 through June 2003. The flow augmentation analysis was done for the period January 1982 through June 2003; this was the historical period when flows in the middle James River were affected by the U.S. Army Corps of Engineers via operations at Lake Moomaw.

MINIMUM INSTREAM FLOW RULES

The primary premise for operating the Cobbs Creek Reservoir Project is to store water from the James River during normal to high flow periods and release water back to the river during low flow periods. Both the safe yield analysis and the flow augmentation analysis incorporate the rules of the current RMP regarding flowby volumes in the river reach and canal maintenance flows.

The current RMP requires flowby that varies with natural river flow and with season. **Figure 4** indicates graphically the flowby requirements and flow available for storage for the period November through June. **Figure 5** indicates the same information for the period July through October. Figure 5 shows a fluctuating pattern of flow available for storage between the natural flow levels of 2200 and 2700 cfs which, to some, might seem counter-intuitive. This is because twice in this range of natural flows, the reduction in the amount of the flowby value is 200 cfs (as shown on the red line of this figure) while the reduction in the amount of the natural flow value is only 100 cfs.

Figure 4

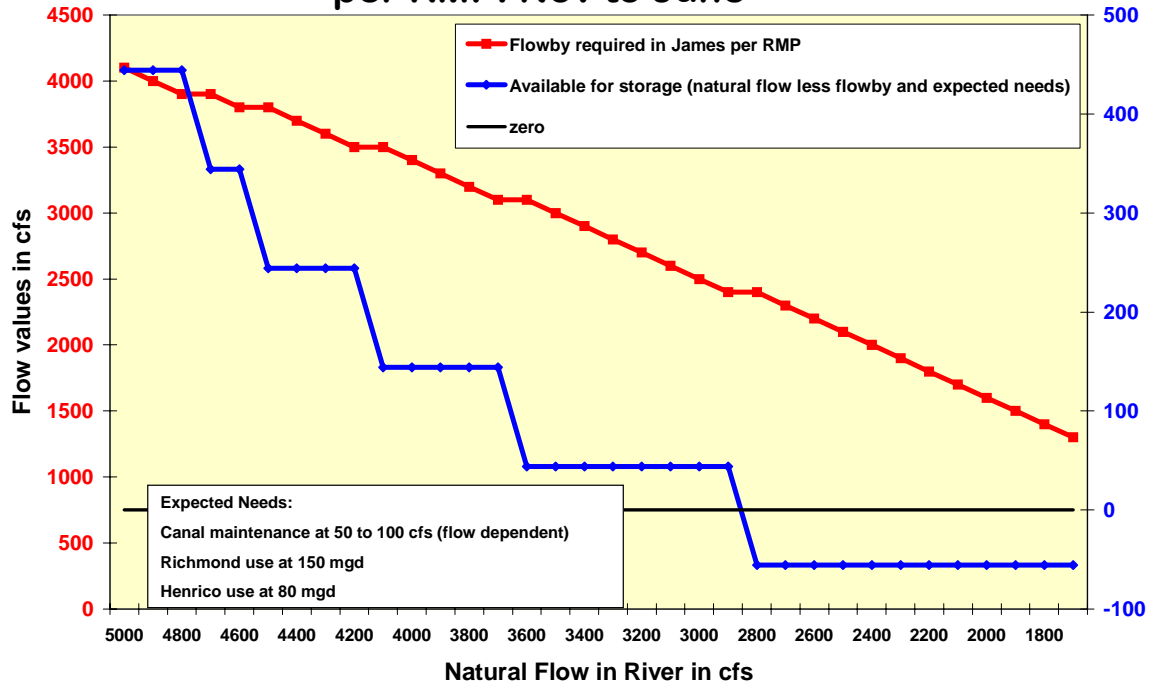
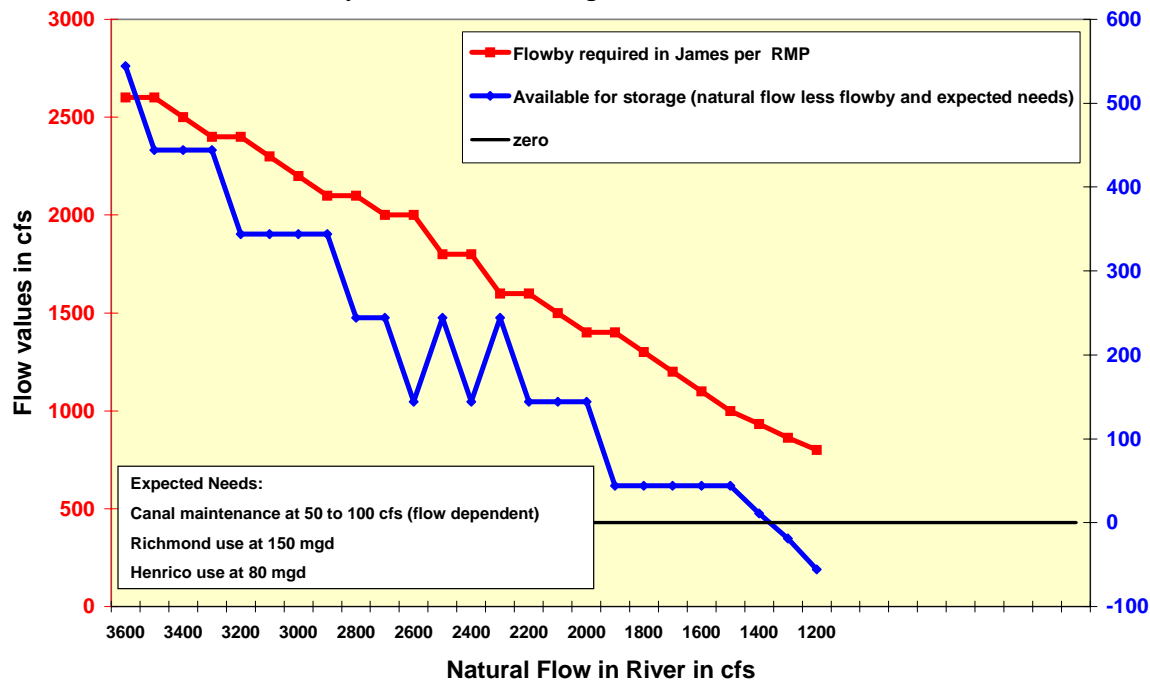
**Flow Available for Storage in Cumberland Project
per RMP: Nov to June**

Figure 5

**Flow Available for Storage in Cumberland Project
per RMP: July to Oct**

The components of flow allocation indicated in Figures 4 and 5 are:

- Flowby to be maintained in the river reach (per RMP requirements),
- The volume needed for canal maintenance flows (per RMP requirements), and
- Volumes for public water supply use by the City of Richmond (150 mgd) and Henrico County (80 mgd).

Any natural river flow in excess of these flow allocation volumes is considered to be available for potential storage in the Cobbs Creek Reservoir Project.

The RMP rules are based on 7-day rolling average natural river flows at Henrico County's intake. A drainage area adjustment factor of 1.08 was applied to daily flow measured at Cartersville to estimate natural river flow in the Richmond area for these analyses. This natural river flow value was then reduced by the allocations explained above to determine a volume of flow available at Henrico County's intake. That value was then adjusted by applying the drainage area adjustment factor to estimate a volume of flow available at Cartersville to be stored in the Cobbs Creek Reservoir Project.

RELEASES FOR FLOW AUGMENTATION

The safe yield analysis simulates traditional reservoir operations for release of stored water. No flow augmentation releases are made in the safe yield analysis.

The flow augmentation analysis simulated augmentation releases under two conditions:

- 1) When natural flows are below the trigger in the RMP which requires Richmond and Henrico County to institute mandatory water conservation measures (trigger for mandatory conservation), and
- 2) When natural flows are below the trigger in the RMP which requires Richmond and Henrico County to institute voluntary water conservation measures (trigger for voluntary conservation).

The natural flow value which is compared to the RMP triggers is the flow measured at Cartersville, adjusted by the drainage area adjustment factor, and averaged over a 14-day period per the requirements of the RMP. The RMP requirements base flowby values in the river on 7-day rolling averages while the triggers for water use restrictions are based on 14-day rolling averages.

The triggers for mandatory conservation and for voluntary conservation in the RMP are seasonal and are listed in **Table 1**.

Table 1

Flow Triggers for Conservation Measures per RMP

	November to June	July to October
Trigger for Mandatory Conservation	1250 cfs	700 cfs
Trigger for Voluntary Conservation	1700 cfs	1200 cfs

Values compared to 14-day rolling average of natural river flow at Henrico County's intake

FLOW AUGMENTATION WHEN NATURAL FLOW IS BELOW THE TRIGGER FOR MANDATORY CONSERVATION

On any day when the 14-day rolling average natural flow is below the trigger for mandatory conservation, then the flow augmentation release is set equal to the difference between the day's trigger for mandatory conservation and that day's flow.

In order to ensure that the 14-day rolling average flow during a low-flow augmentation period stays above the trigger for mandatory conservation, there are two additional special instances when a flow augmentation release is made. The first is on any day when today's flow is less than the trigger for mandatory conservation (regardless of the value of the 14-day rolling average flow). The second is for the period of October 18 through October 31. If the 14-day rolling average flow is below the October trigger for voluntary conservation of 1200 cfs, then the flow augmentation release is set equal to the difference between November's trigger for mandatory conservation of 1250 cfs and the day's flow.

No cap was set on the daily amount of water needed to be released for flow augmentation.

FLOW AUGMENTATION WHEN NATURAL FLOW IS BELOW THE TRIGGER FOR VOLUNTARY CONSERVATION

On any day when the 14-day rolling average natural flow is below the trigger for voluntary conservation, then the flow augmentation release is set equal to 10 percent of the volume of water used by Richmond and Henrico under expected future maximum day conditions (150 mgd and 80 mgd respectively). This represents the potential volume of water saved if those systems instituted voluntary conservation measures. Thus, flow augmentation release on days when natural flow is below the trigger for voluntary conservation would alleviate the need for Richmond and Henrico to institute voluntary conservation measures.

SUMMARY OF MODEL ASSUMPTIONS

The key assumptions used in the modeling analysis are listed below. They are consistent with guidance given by DEQ staff during December 2003 discussions of model methods, assumptions and details.

- Daily calculations are performed to simulate the withdrawal of water from the James River and to determine the amount of flow augmentation release. A monthly time step is used to simulate reservoir operations.
- Rules for determining the volume of water available to be withdrawn from the James River are taken from the current RMP for the Falls of the James Area.
- Flow augmentation releases from the reservoir during dry times occur in two conditions: when river flow is low enough to trigger the requirement for voluntary conservation measures and when flow is low enough to trigger mandatory conservation measures.
- Augmentation release, on any day when the 14-day rolling average natural flow is below the trigger for mandatory conservation, is set equal to the difference between today's trigger for mandatory conservation and today's flow.
- Augmentation release, on any day when the 14-day rolling average natural flow is below the trigger for voluntary conservation, is set equal to 10 percent of the volume of water used by Richmond and Henrico under expected future maximum day conditions (150 mgd and 80 mgd, respectively).
- Analyses assume 25 percent of total reservoir volume is unusable. Flow augmentation analysis holds 10 percent of usable volume for use by Cumberland County.